

Cross Section Measurements in the MIPP experiment

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What is MIPP?

The MIPP experiment uses 120 GeV/c protons and secondary beams of pions, kaons, and protons of both charges at momenta of 5 to 90 GeV/c to measure particle production cross sections on fixed thin targets spanning the periodic table from LH2 to U. The versatile experiment addresses many physics topics and provides data of use to neutrino experiments (MINOS, NOvA, planned experiments at DUSEL, etc.), hadronic shower simulators, and more.

What is on this poster?

Here we present preliminary results from data collected in 2005.

- KNO scaling behavior of pp multiplicities at different beam momenta is compared to a fit to previous data.
- Cross sections of pions produced by 60 GeV/c π^+ , K^+ , and p beams on carbon for different production angles.
- Cross sections of pions and kaons produced by 120 GeV/c protons on carbon

Cross sections are determined from data according to

$$\frac{d^2\sigma}{dp d\Omega}(p, \cos\theta) = \frac{A}{2\pi N_A \rho} \frac{1}{a(p, \cos\theta)} \frac{Y_f(p, \cos\theta) - Y_{mt}(p, \cos\theta)}{N_b (\Delta p) (\Delta \cos\theta)}$$

A = Atomic weight of the target

N_A = Avogadro's number

ρ = Area density of the target

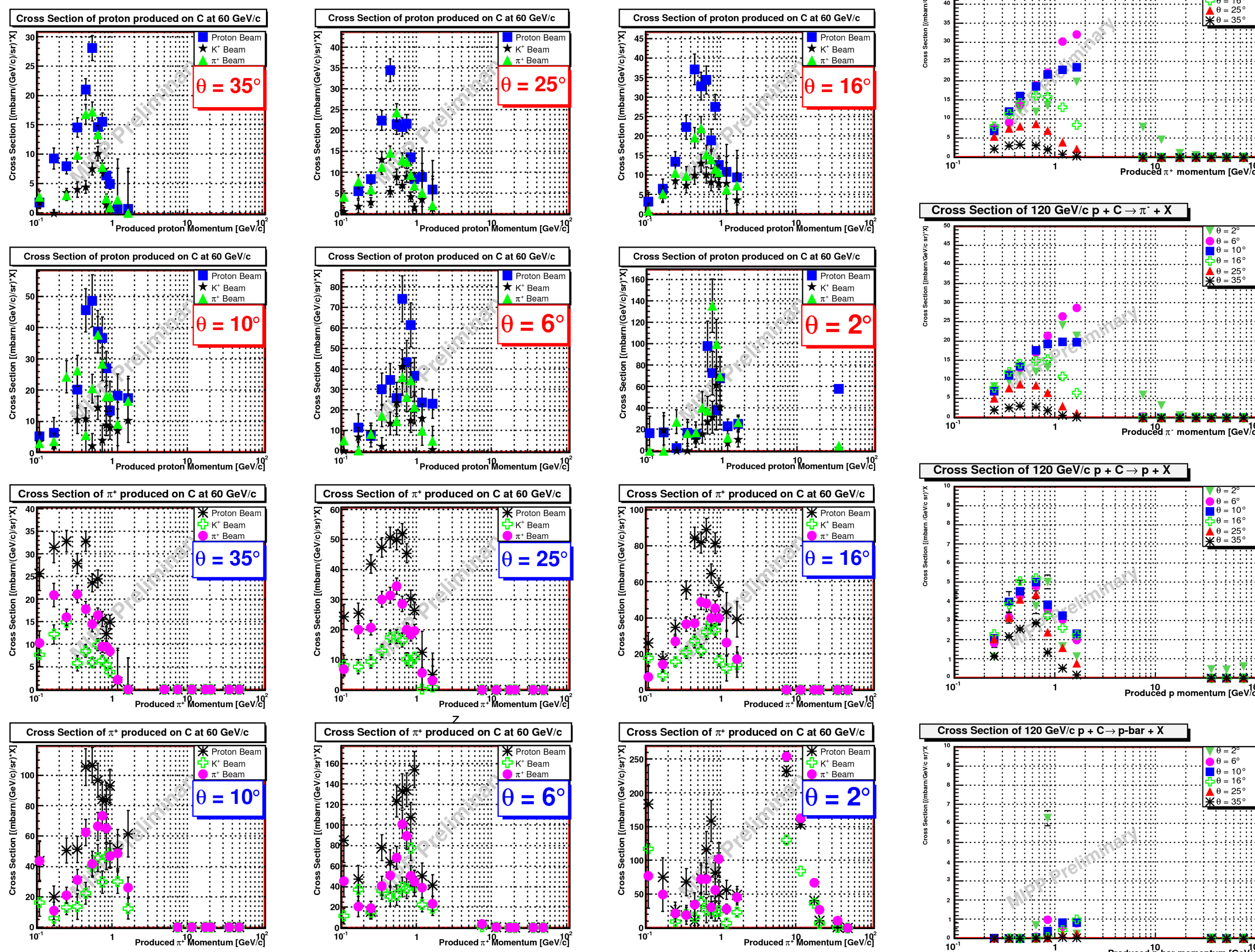
N_b = Incident beam flux

$a(p, \cos\theta)$ = Acceptance values

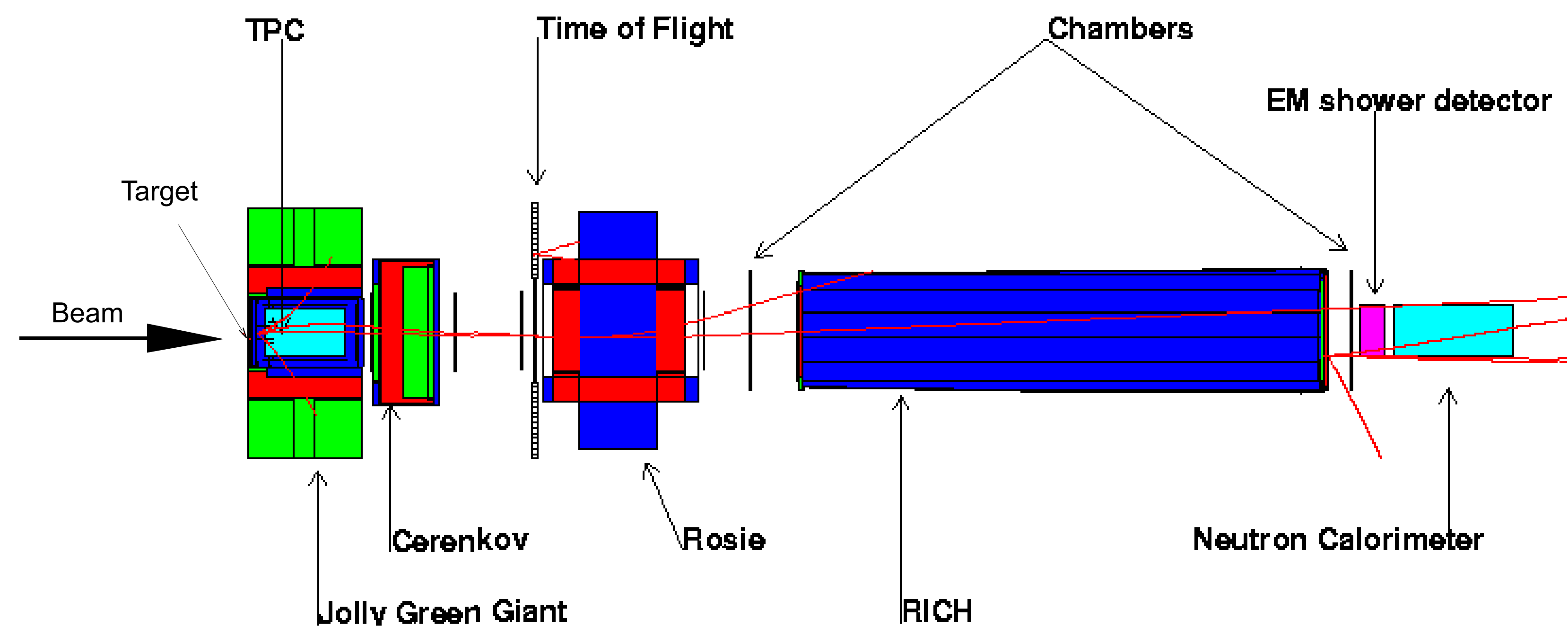
$\Delta p, \Delta \cos\theta$ = The momentum and polar angle bin sizes

$Y_f(p, \cos\theta)$ = number of produced particles in bins

$Y_{mt}(p, \cos\theta)$ = number of the produced particles on empty target



Only statistical errors are shown in all cross section plots. Systematic errors are under investigation.



The MIPP detector system

The Tracking detectors measure the momenta of ~all charged particles to 5% or better.

TPC

The Time Projection Chamber inside the Jolly Green Giant (JGG) magnetic field of 0.7 T measures all tracks originating from the target immediately upstream of the TPC.

- 128 pad rows with 120 pads each.
- transverse vertex resolution ~1mm

Wire chambers

The 9 wire chambers with 4 planes each and ~3 mm wire spacing define the beam particle trajectory and measure the track position downstream of the TPC. The chambers form a second spectrometer with the Rosie magnet to improve momentum resolution at large momenta and also increase acceptance of the detectors downstream of Rosie.

Beam chambers (BCs)

- 10 cm x 15 cm with 160 wires per plane

Drift chambers (DCs)

- DC1 has 183 cm x 122 cm active area with 512 wires per plane
- DC2-4 have 152 cm x 101 cm active area with 512 or 448 wires per plane

Proportional chambers (PWCs)

- 2 m x 2 m with 640 wires per plane.

The particle id detectors distinguish between π , K, and p over almost the entire range of momenta of produced particles.

Beam Cherenkovs

- two differential Cherenkov counters identify the beam particle

TPC

- dE/dx in the TPC separates particles below 1 GeV/c

TOF

- 54 scintillator bars form a TOF wall of 3.5 m x 3.0 m to identify particles below 2 GeV/c.
- Time resolution is ~350 ps for isolated tracks and degrades when adjacent channels are hit. An electronics upgrade could eliminate this cross talk.

Multicell Cherenkov (Ckov)

- 96 cells detect Cherenkov light of particles passing through this detector. Thresholds are at 2.5 GeV/c, 8.9 GeV/c, and 17.5 GeV/c for π , K, and p, respectively.

Ring Imaging Cherenkov (RICH)

- 3000 pmts of 0.5" diameter image rings above thresholds of 4.5 GeV/c, 17 GeV/c, and 31 GeV/c
- 10 m long CO₂ radiator gives on average 26 pmt hits per ring

Calorimeters

- EMCal and HCal measure electromagnetic and hadronic energy deposits
- gas tubes and lead in EMCal, steel and scintillator in HCal

The MIPP Upgrade

With modest upgrades MIPP will be able to take more data to complete the physics program intended for the first run and to expand the physics reach further: high statistics data on all nuclei of interest, tagged neutral beams,

The total cost for the upgrade is roughly \$1.5 million.

- repair of the JGG magnet coils: **New coils have been designed, fabricated and are at Fermilab now.**

This repair is necessary because the JGG coils failed at the end of the first run.

- faster readout for TPC: **Altro/Pasa chips (used by Alice) have been purchased and prototype boards are being tested.**

With the faster readout MIPP will be able to **collect 5,000,000 events of data per day** with less than 5% impact on other accelerator operations (p-bar stacking, fast spill protons for NuMI, etc.).

- the plastic ball detector from GSI/KVI will instrument the hemisphere upstream of the target.

This will measure nuclear recoil particles.

- beam halo veto wall and beam line improvements. Will enable measurements at beam momenta down to 1 GeV/c.

- silicon pixels. Will improve interaction trigger and vertex resolution.

- new TOF readout. Will eliminate cross talk that degrades tof resolution.



The upgrade collaboration is growing.

- Russia, Germany, Netherlands, India, US, ...

MIPP collaboration member universities and laboratories:

